AEG

Power Solutions

Protect PV.250
Operating Instructions

AEG Power Solutions GmbH
Department: PS TED
Name: Wegener/Schenuit
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1 General Information

The Protect PV.250 is a solar inverter (INV) that feeds the electrical energy produced by the PV cells into an AC voltage mains.

The Protect PV.250 is available in two basic versions:

- For feeding into a low-voltage mains (e.g. 400 VAC)
- For feeding into a medium-voltage mains (e.g. 10 kV; 20 kV; 33 kV)

The required mains transformer is **not** supplied with either version of the unit and can be ordered as an extra if necessary.

It is possible to combine two Protect PV.250 units to create a 500 kW system.

With the low-voltage version, each Protect PV.250 has its own isolating transformer, whereas a shared isolating transformer can be used for the medium-voltage version (in this case, each Protect PV.250 has an electrically isolated low-voltage connection).

500 kW systems can be made to support "partner operation" to increase their efficiency.

The nameplate, featuring all relevant data, can be found on the AC panel on the inside of the door.

NOTE:

Important information about Protect PV.250 documentation
Further descriptions and unit diagrams are included in the document folder.

1.1 Technology

Due to the utilisation of high-performance electronic components, the Protect PV.250 boasts a very high degree of operational reliability, is extremely efficient and is characterised by its versatility in communicating with other systems by means of interfaces.

The entire control electronics of the Protect PV.250 are based on microcomputer assemblies. The fact that the various assemblies are logically integrated and linked into the overall system means that unit properties can be defined by making unit-specific parameter settings in the software.

Information is exchanged between the individual modules using the CAN bus (Controller Area Network). This CAN bus features high interference immunity and is used in a wide variety of industrial applications.

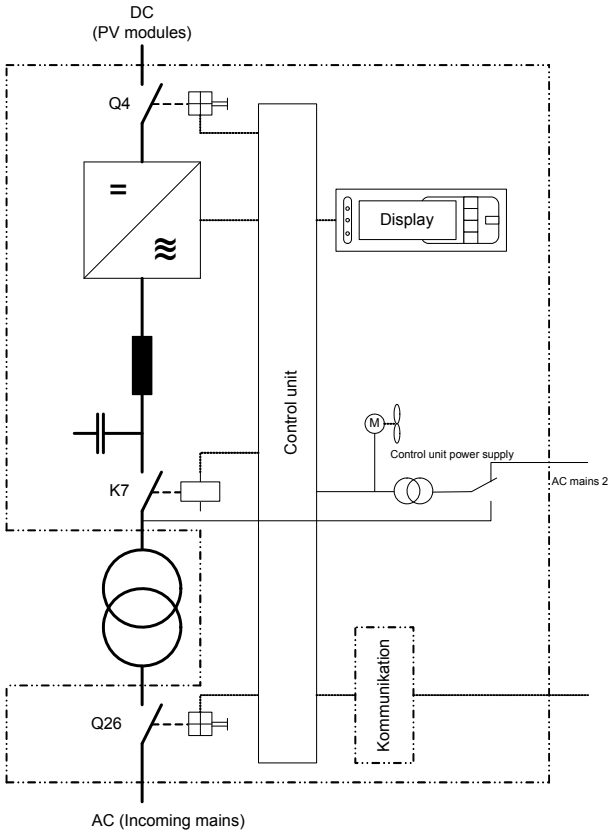

Fig. 1 Functional principle of the Protect PV.250 for connection to a low-voltage mains

The main assemblies of the inverter are (Fig. 1):

- DC load interrupter switch Q4
- Inverter stack, display and control unit with communication components
- AC filter
- Inverter output contactor K7
- Mains transformer
- Mains disconnector Q26
- Mains filter choke (only on MV version) L26 (see Fig. 2)

Fig. 1 illustrates the principle of the Protect PV.250.

The PV cells supply the INV stack with DC voltage via DC load interrupter switch Q4. The INV stack converts this DC voltage into a 3-phase AC voltage. A sinusoidal current is fed into the mains via the AC filter, contactor K7 and the mains transformer.

Mains disconnector Q26 and load interrupter switch Q4 are provided for isolating the inverter in the event of unit faults or when maintenance needs to be performed on the unit.

CAUTION:
Potentially fatal voltages are present at the terminals on the Protect PV.250.

The control unit is supplied with power from the AC mains or, optionally, from a second AC mains.

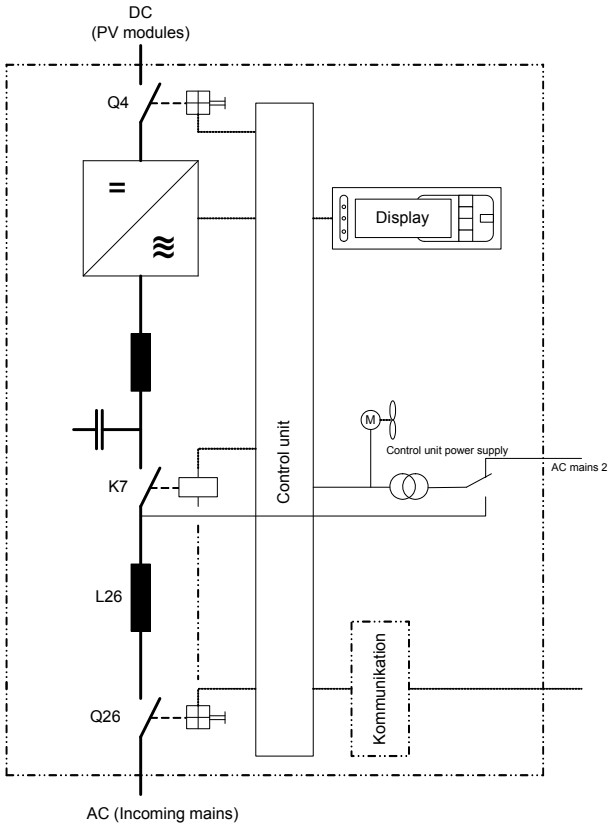

Fig. 2 Functional principle of the Protect PV.250 for connection to a medium-voltage mains

1.2 Operating Elements

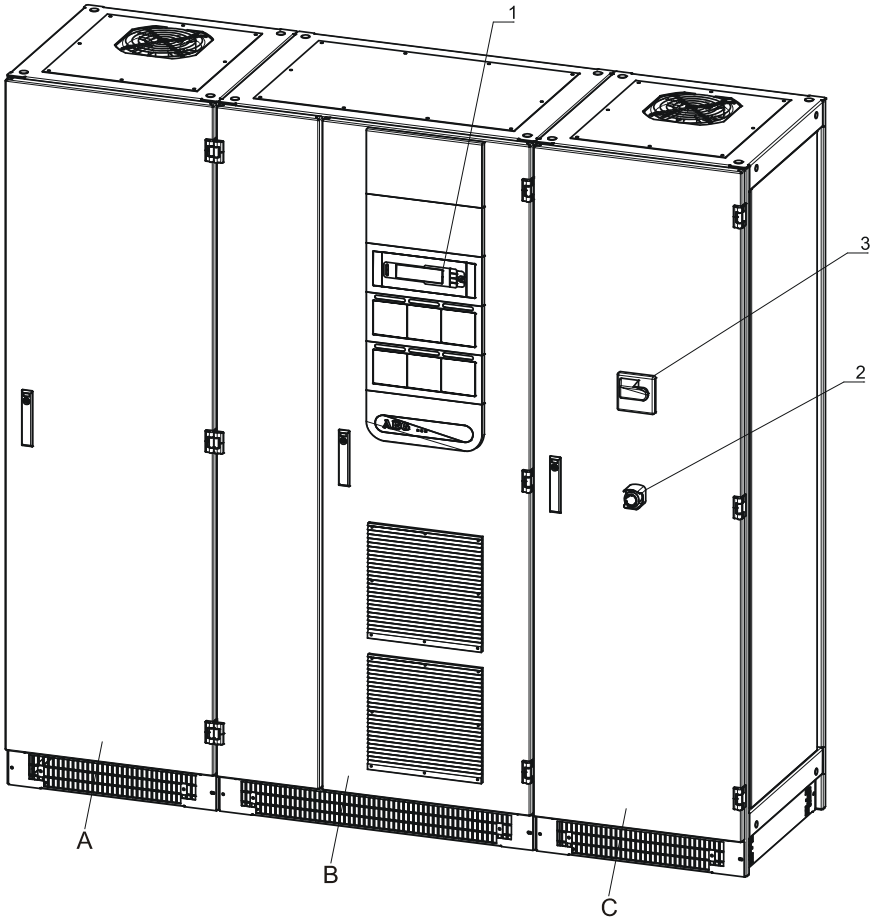

Fig. 3 Arrangement of the operating elements on the doors

Item	Designation
1	Display and operation unit (DOU)
2	Emergency off
3	Q26 mains disconnector PV.250
A	DC panel +DCD
B	INV cabinet +INV
C	AC panel +ACD

1.3 View of the Cabinet

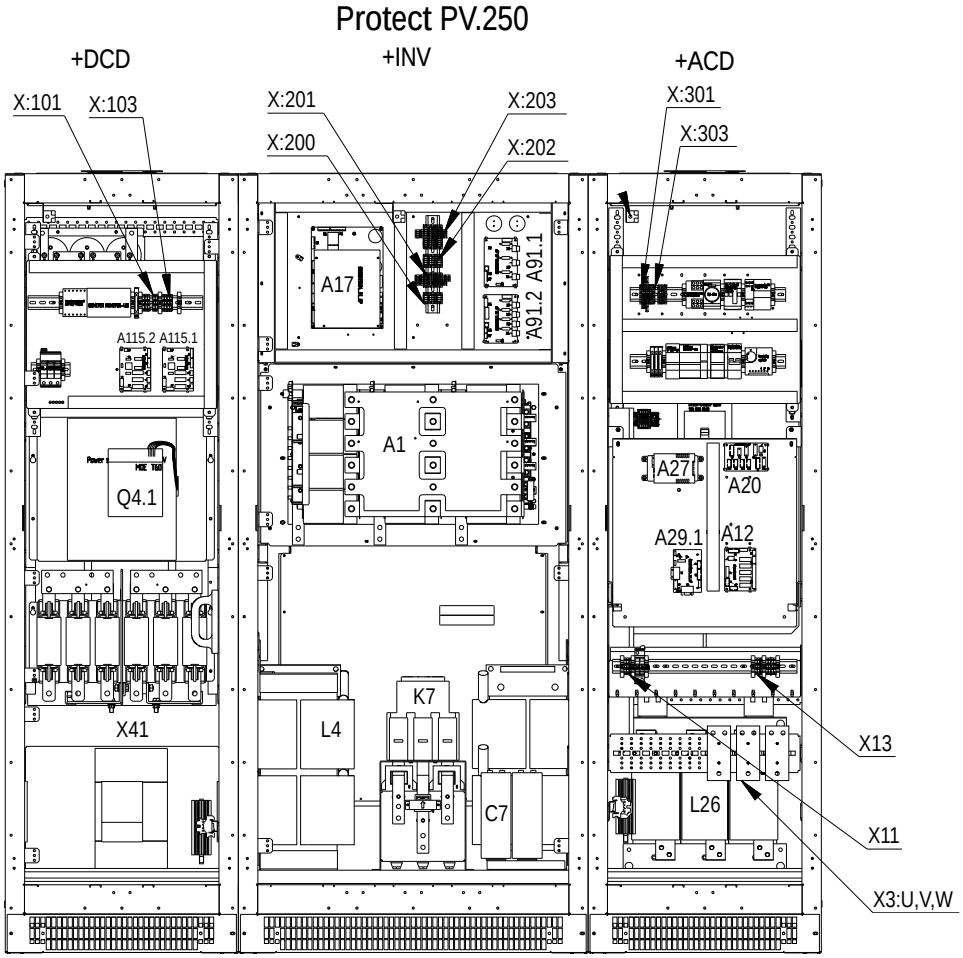

Fig. 4 Arrangement of the operating elements, components and individual PCBs with doors open

NOTE:
The image above may not always be strictly accurate, depending on which options have been selected.

Item	Designation
A1	Power stack 250 kW
A115.1-A115.2	CAN I/O
A12	Remote signalling
A17	PV INV interface
A20	Partner operation
A27	COM server
A29.1-A29.2	Multicom CCC
A30	Modem PV
A91.1,A91.2	Fan monitoring
F41	Input fuse DC voltage (DC)
K7	Inverter output contactor
L26	Mains filter choke (only on MV version)
Q4.1	DC load interrupter switch
X3	Inverter output/mains connection
X11	Power supply mains 2
X13	230 VAC client terminal
X200-X203	Terminal layout, cabinet connection
X41	Input terminals DC voltage (DC)

2 Safety Instructions

NOTE:
All the key safety instructions are specified in the document entitled "**Installation Instructions and Start-Up**".

3 System Description

3.1 General

This chapter describes the operating modes and functions of the Protect PV.250.

3.2 Operating Modes

Two different operating modes may be used:

- Individual operation
- Partner operation

3.2.1 Individual Operation

In individual operation, the inverter works independently and is not connected to any other inverters. The DC infeed from the PV cells and the link to the AC mains are only connected to this inverter. Switching operations, control commands and modifications to setting parameters are only performed by the unit concerned.

3.2.2 Partner Operation

In partner operation, two inverters are connected via a CAN bus. The DC voltage infeeds of both units can be linked using a tie switch. Levels of efficiency can be increased in this operating mode by running one inverter on two connected PV cells at less than full power. It is the inverter itself that connects and disconnects the DC voltage; it is also responsible for switching the units on and off.
This operating mode is described in detail in Chapter 4.5.

4 System Function

4.1 Description of Sequence Control

As soon as the control assembly of the Protect PV.250 is supplied with voltage, sequence control starts.

Initially, the load interrupter switch Q4 remains open. Once the initialisation phase is complete and if no deactivating and self-acknowledging faults are pending, the load interrupter switch Q4 is closed in the "Waiting for feed conditions" status. During subsequent operation, the switch is only opened by deactivating faults (see Chapter 5).

The inverter output contactor K7 remains open initially. The contactor is switched by sequence control.

The sequence control statuses are shown in graphic format in Fig. 5.

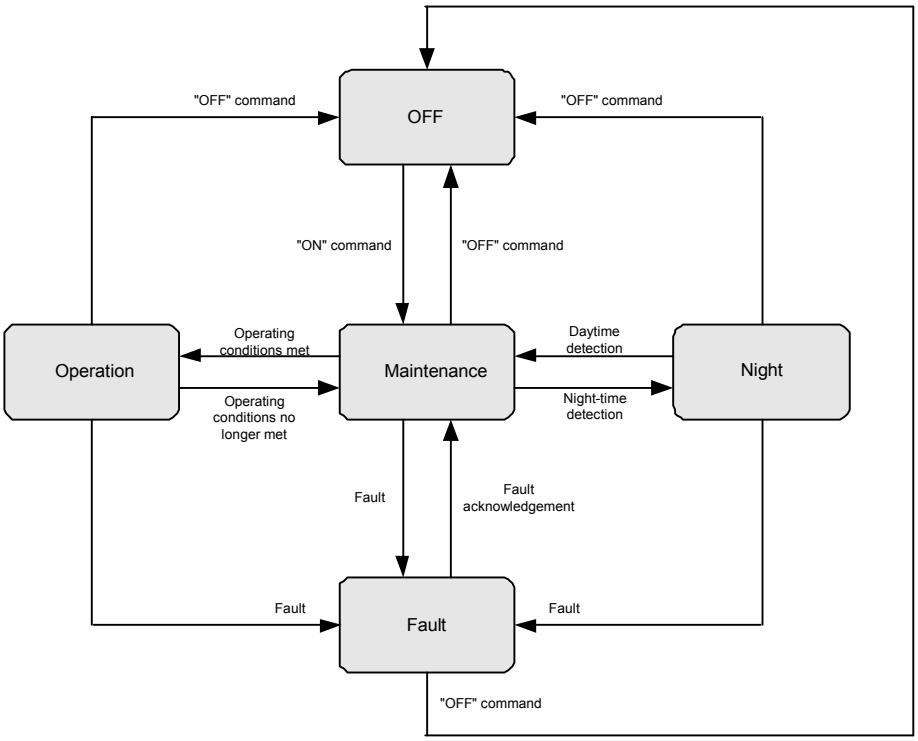

Fig. 5 Sequence control

4.1.1 The "Off" Status

The Protect PV.250 has been switched off logically via the DOU or the master control unit.

The unit is running without faults, the monitoring systems are not activated.

In this status, no power is fed into the mains.

Possible change of status:
The status can be switched from "OFF" to "Waiting for feed conditions" by switching the unit on via the DOU and the master control unit.

4.1.2 The "Waiting for feed conditions" Status

In this status, the Protect PV.250 monitors the DC voltage of the PV cells that is present at the unit, as well as the mains voltage and the mains frequency.

The monitoring systems are activated.

In this status, no power is fed into the mains.

Possible change of status:
If the DC voltage rises above a certain value for a certain time and the mains voltage and mains frequency are within a certain range, the unit switches to the "Operation" status. An attempt to start up is made which involves switching on the inverter stack. If the DC voltage collapses too dramatically during this start-up attempt, the stack is switched off again and there is a delay until the next start-up attempt is made. The unit will not switch to the "Operation" status until a start-up attempt during which the DC voltage does not dip too significantly.
If the DC voltage falls below a certain value for a certain time, the unit switches to the "Night" status.
If a deactivating or self-acknowledging fault is triggered, the unit switches to the "Fault" status.
The status can be switched from "Waiting for feed conditions" to "OFF" using the "Off" control command.

4.1.3 The "Operation" Status

The Protect PV.250 has met all conditions for operation and no deactivating or self-acknowledging faults are present.

The monitoring systems are activated.

In this status, power is fed into the mains and the inverter output contactor K7 is closed.

Possible change of status:
If the generated power falls below a certain value for a certain time, the operating conditions are no longer met. The unit then switches to the "Waiting" status.

If a deactivating or self-acknowledging fault is triggered, the unit switches to the "Fault" status.

The status can be switched from "Operation" to "OFF" using the "Off" control command.

4.1.4 The "Waiting" Status

If the power fed in falls below a certain value in "Operation", the unit switches to the "Waiting" status. Although the incoming power is low, the DC voltage of the PV cell could still be high enough and even stable enough to meet the feed conditions in the "Waiting for feed conditions" status. So that the inverter does not switch back on again immediately, thereby subjecting the inverter output contactor K7 to unnecessary load due to frequent switching, after the "Operation" status the unit initially switches to the "Waiting" status. It remains in this status for a certain time, only switching to the "Waiting for feed conditions" status once this time has elapsed.

The monitoring systems are activated.

Possible change of status:

Once the delay has elapsed, the unit switches to the "Waiting for feed conditions" status.

If a deactivating or self-acknowledging fault is triggered, the unit switches to the "Fault" status.

The status can be switched from "Operation" to "OFF" using the "Off" control command.

4.1.5 The "Fault" Status

If a deactivating or self-acknowledging fault is triggered (see Chapter 5), the unit switches to the "Fault" status.

The monitoring systems are activated.

In this status, no power is fed into the mains.

Possible change of status:

If a self-acknowledging fault has been triggered and this fault does indeed acknowledge itself, the unit switches to the "Waiting for feed conditions" status.

If a deactivating fault has been triggered, the "Acknowledge fault" control command can be used to switch the unit back to the "Waiting" status".

The status can be switched from "Fault" to "OFF" using the "Off" control command. In the "OFF" status, the unit is always free of faults.

4.1.6 The "Night" Status

If the DC voltage falls below a certain value for a certain time, the Protect PV.250 switches to the "Night" status.

The monitoring systems are activated.

In this status, no power is fed into the mains.

Possible change of status:

If, the following morning, the DC voltage rises above a certain value for a certain time, the unit switches to the "Waiting for feed conditions" status.

If a deactivating or self-acknowledging fault is triggered, the unit switches to the "Fault" status.

The status can be switched from "Operation" to "OFF" using the "Off" control command.

4.1.7 Sequence Control During the Course of the Day

Early morning:

The Protect PV.250 is in the "Night" status. The sun's rays increase the DC voltage generated by the PV cells. If this voltage stays above a certain value for a certain time, the unit switches to the "Waiting for feed conditions" status.

The DC voltage continues to be monitored in this status. In order for a start-up attempt to be made, it must remain above a certain value for a certain time. The mains voltage and mains frequency are also checked. These values must be within certain limits.

If the DC voltage continues to increase due to the sun's rays getting stronger and the mains voltage and mains frequency are within acceptable limits, a start-up attempt is made. During a start-up attempt, the inverter stack is switched on, thereby drawing power from the DC voltage that is present. The inverter output contactor is open during a start-up attempt. If the load on the DC voltage causes it to collapse too dramatically during this start-up attempt, the stack is switched off again and there is a delay until the next start-up attempt is made. If the DC voltage does not dip too significantly, the inverter output contactor closes and power is fed into the mains. The inverter is now in the "Operation" status.

Day:

During the course of the day, the inverter will remain in the "Operation" status if the sun's rays are strong enough and no faults occur. Power is fed into the mains and the inverter output contactor K7 is closed.

Evening:

As the sun goes down, the power fed into the mains decreases. If this power falls below a certain value for a certain time, the operating conditions are no longer met. The inverter stack is switched off, the inverter output contactor K7 opens and the unit switches to the "Waiting" status.

Once the "Waiting" status delay has elapsed, the unit switches back to "Waiting for feed conditions". Although the sun's rays are not as strong, the DC voltage might still be high enough for a successful start-up attempt with the inverter stack and the inverter output contactor K7 being switched on again. However, because the sun's rays are not as strong, it is unlikely that the operating conditions will still be met in the "Operation" status. As a result, the unit will switch back to the "Waiting" status once a delay has elapsed. When the unit switches back to this status, the delay is extended until the unit switches back to the "Waiting for feed conditions" status.

The cyclic changes of status "Operation" -> "Waiting" -> "Waiting for feed conditions" -> "Operation" can take place several times depending on insolation, the time of year, location and other conditions (e.g. snow on the PV cells). So that the inverter output contactor K7 is not overloaded by this cycle of changes, the delay in the "Waiting" status is extended every time the unit switches to this status.

This has very little effect on the energy fed in, because the low levels of insolation mean that hardly any energy is being generated.

Later in the evening:

Levels of insolation continue to fall. As a result, the DC voltage drops again. If the DC voltage drops below a certain value for a certain time, no more start-up attempts are made. If the DC voltage continues to drop, the unit switches to the "Night" status.

Night:

The Protect PV.250 shuts down all possible loads so that as little energy as possible is being consumed. The inverter remains in the "Night" status until the following morning.

4.1.8 Sequence Control Parameters

Switch-on conditions: Underfrequency, overfrequency, undervoltage, overvoltage:
The unit will only switch from the "Waiting for feed conditions" status to the "Operation" status if the feed conditions are met. These conditions include the mains voltage and the mains frequency. These values must be within certain limits, which are described with the switch-on conditions.

Voltage limit value for night detection,
delay time for night detection:
If the DC voltage falls below the voltage limit value for longer than the delay time, the unit switches to the "Night" status.

Voltage limit value for day detection,
delay time for day detection:
If the DC voltage rises above the voltage limit value for longer than the delay time, the unit switches to the "Waiting for feed conditions" status.

Stack switch-on time:
The time for which the inverter stack is switched on during a start-up attempt

Permissible voltage dip after switching on the stack:
Prior to the start-up attempt, a limit value is calculated from the instantaneous DC voltage and the permissible voltage dip.

If the start-up attempt causes the DC voltage to fall below this calculated limit value, this start-up attempt will fail.

Delay until the next start-up attempt following failure on account of excess voltage dip:
After the failure of a start-up attempt, this delay must elapse before the next start-up attempt is made.

Power limit value for shutdown,
delay time for shutdown:
If the power fed into the mains is below the limit value for longer than the delay time, the unit switches to the "Waiting" status.

Standard delay for a renewed start-up attempt following shutdown,
offset delay added to the standard delay after shutdown,
maximum number of times the offset delay can be added to the standard delay:
Variable delay in the "Waiting" status, see also Chapter 4.1.4.

Minimum DC voltage,
fill factor (PV system parameter):
If the DC voltage rises above a value resulting from the minimum DC voltage divided by the fill factor, a start-up attempt is made.

4.2 Description of Fan Control

4.2.1 General

The Protect PV.250 features temperature-dependent fan control. The fans are either switched off or run on a fast or slow fan stage. Fan control extends the operating time of the fans, minimises the noise generated by the fans and improves the efficiency of the unit by reducing its power consumption.

As soon as the control assembly of the Protect PV.250 is supplied with voltage, fan control always starts with the fast fan stage. The control can be restarted to check whether the fans are working correctly. For example, after maintenance work, it is not necessary to wait for the fans to reach the temperature criterion to switch on the fast fan stage.

The fast fan stage is always active for at least a certain time. The IGBT stack temperature is checked after this time. If it is below a certain value, fan control switches to the slow fan stage.
The IGBT stack temperature is also checked in the slow fan stage. If it is below a certain value, the fans are switched off. However, if the temperature rises again during operation with the lower fan stage, fan control switches back to the fast fan stage.

If the IGBT stack temperature rises above a certain value with the fans switched off, fan control switches to the fast fan stage.

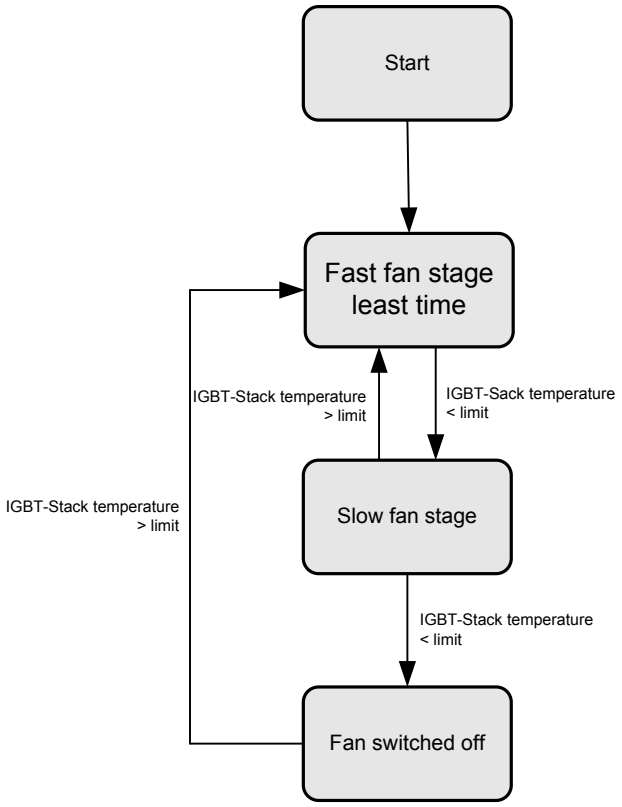

Fig. 6 Fan control

4.2.2 Fan Control Parameters

Stack temperature limit value for switching on the fan:
If the IGBT stack temperature rises above this limit value, the fans which were switched off are switched to the fast fan stage.

Stack temperature limit value for switching off the fan:
If the IGBT stack temperature falls below this limit value, the fans which were running in the slow fan stage are switched off.

Stack temperature limit value for switching to the fast fan stage:
If the IGBT stack temperature rises above this limit value, the fans which were running in the slow fan stage are switched to the fast fan stage.

Stack temperature limit value for switching to the slow fan stage:
Minimum time in the fast fan stage:
If the IGBT stack temperature falls below this limit value, the fans which were running in the fast fan stage are switched to the slow fan stage if the minimum time in the fast fan stage has elapsed.

4.3 Insulation Monitoring and Earthing of PV Cells

4.3.1 General

Insulation measurements and tests are carried out with a "Bender A-ISOMETER IRDH275B". This device detects and checks the insulation resistance.

The insulation resistance detected is compared with two limit values stored in the isometer. If the insulation resistance is below one of the limit values, the device generates a signal. If the limit value is below the other limit value, the device generates a second signal. The limit values can be displayed and even modified on the isometer.

The insulation resistance detected and the two signals are sent to the Protect PV.250 control. The insulation resistance is displayed as a measured value. Signalling faults are generated from the two isometer signals, see Chapter 5.

Sequence control behaviour differs depending on which solar cells are connected.

The solar cells do not need to be earthed for operation with monocrystalline or polycrystalline solar cells. Insulation measurement is always active.

In the case of operation with thin-film solar cells, the solar cells have to be earthed. Insulation measurement is not active during earthing.

Insulation measurement sequence control features a "Maintenance mode". This mode can only be activated for thin-film solar cells. Activating this mode removes earthing. This can be useful when mowing areas where solar panels are installed, for example.

4.3.2 Operation With Monocrystalline or Polycrystalline Cells

General:

This type of solar cell does not require active earthing.

Sequence control:

Insulation monitoring is always active.

Maintenance mode:

No action in the event of a "maintenance mode" command.

Starting the insulation test manually:

No action, since the insulation test is always active.

4.3.3 Operation With Thin-Film Solar Cells

General:

This type of solar cell requires active earthing.

Active earthing is switched on during the day and switches off at night; an insulation test is carried out whilst the earthing is switched off.

When active earthing is switched on, the digital signals and analogue signal from the Bender Isometer are ignored.

Once active earthing is switched off, a certain time is allowed to elapse before the digital signals from the isometer are evaluated and the analogue measured value is output.

Sequence control:

When the Protect PV.250 sequence control switches to the "Night" status (see Chapter 4.1.6), the active earthing is switched off once a certain time has elapsed.

The insulation test starts with a delay; after a certain test time the insulation test is terminated and active earthing is switched back on. If the sequence control switches to the "Operation" status before the test time has elapsed, the timer control is ignored, the insulation test is terminated and active earthing is switched back on.

Maintenance mode:

Maintenance mode can be triggered either via a command or by means of remote signalling. Active earthing switches off immediately when maintenance mode is activated. However, the digital and analogue signals from the isometer continue to be ignored. Active earthing is switched on again the next time a switch is made to the "Operation" status. However, the unit remains in maintenance mode for at least a certain time; i.e. even on a change of status to "Operation", maintenance mode is not terminated until this time has elapsed.

Starting the insulation test manually:

The insulation test can be started manually for maintenance work.

Active earthing is switched off after the start of the insulation test and the insulation test starts once a delay has elapsed. When the test period has elapsed the insulation test finishes and the active earthing is switched on again.

The insulation test can only be started manually if an insulation test is not already running at the time.

4.3.4 Insulation Monitoring in Partner Operation

In partner operation (see Chapter 4.5), both inverters are fitted with the isometer.

Insulation measurement in single operation
In single operation, the two inverters behave like two single units. Insulation measurement is active in both inverters.

Insulation measurement in linked operation
In linked operation, the inverters are connected on the DC voltage side. If both inverter isometers were to be active in this operating mode, this would distort the measurement of the insulation resistance. Therefore, in linked operation, the isometer of the inverter which is not active is switched off and its sensors are disconnected from the DC voltage. Now only one isometer is active and the measurement of the insulation resistance is correct.

4.3.5 Insulation Monitoring Parameters

All parameters are only relevant for operation with thin-film solar cells.

Insulation test time:
The analogue and digital signals from the isometer are evaluated during this time.

Delay for insulation test following shutdown of K21:
Once the earthing has been disconnected, this time must elapse before insulation measurement can start.

Delay for shutdown of K21 in night operation:
Once sequence control has switched to the "Night" status (see Chapter 4.1.6), this time must elapse before earthing is removed with contactor K21.

Minimum time in maintenance mode:
If maintenance mode has been activated, the earthing is disconnected and remains so for at least this time.

4.4 MPP Tracker

In the "Operation" status (see Chapter 4.1.3), the inverter detects the maximum power point (MPP) of the PV cells.

The MPP tracker detects the point at which the solar cells give off maximum power.

This enables the system to achieve optimum efficiency.

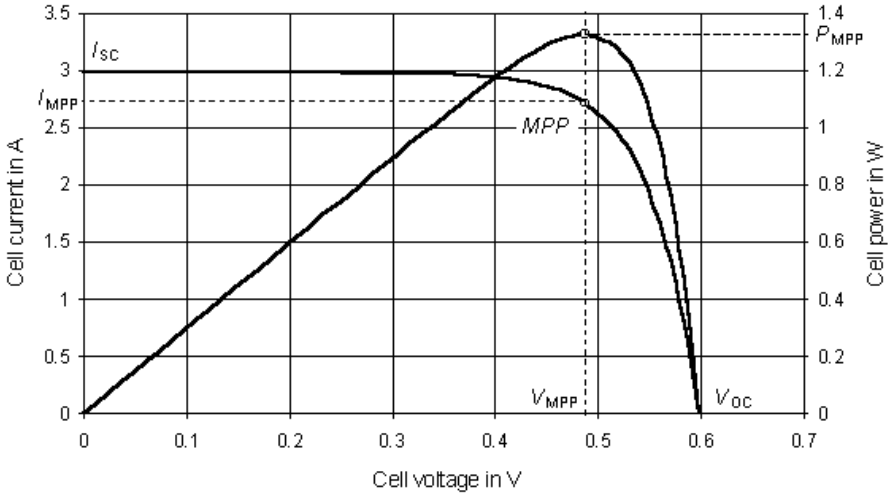

Fig. 7 MPP performance curve

4.5 Partner Operation

In "partner operation", the efficiency of a system with two inverters can be increased by connecting the two PV cells at less than full power.

If insolation levels fall, the PV cells are connected and only one inverter is in operation.

If insolation levels rise, the connection is terminated. Now both inverters are in operation. Each inverter is supplied with power by its associated PV cell.

4.5.1 Linked Operation

One inverter is switched on and is feeding power into the mains. The other inverter is logically switched off. The tie switch is closed.

The inverter which is active in linked operation changes daily.

This operating mode is active when insolation levels are low.

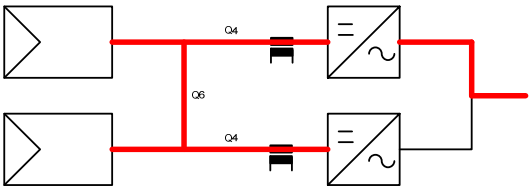

Fig. 8 Linked operation in partner operating mode

Change of status to single operation:
If capacity utilisation in the inverter which is switched on rises above a certain value, once a delay has elapsed, the two inverters are switched to single operation.

First, the inverter which is switched on is switched off. Then, the tie switch is opened. Once the tie switch is open, both inverters are switched on.

Change of status to linked operation in the event of a fault:
In the event of a deactivating or self-acknowledging fault in the inverter which is switched on, the two inverters are switched to linked operation.

The inverter which is switched off is switched on. The faulty inverter is shut down due to the fault.

4.5.2 Single Operation

Both inverters are switched on and are feeding power into the mains. The tie switch is open.

This operating mode is active when insolation levels are high.

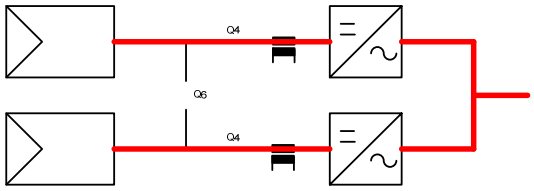

Fig. 9 Single operation in partner operating mode

Change of status to linked operation:
If the capacity utilisation of the two inverters falls below a certain value, once a delay has elapsed, the system switches to linked operation.

The MPP tracker is switched off in both inverters and an attempt is made to regulate the two inverters to the same DC voltage. When the DC voltages are approximately identical, the tie switch is closed. Once the tie switch has been closed, one inverter is switched off. If the DC voltages cannot be regulated to the same value in a certain time, the two MPP trackers are switched back on. Once a delay has elapsed, the MPP trackers are switched back off again and the next attempt to match the DC voltage is started.

Change of status to linked operation in the event of a fault:
In the event of a deactivating or self-acknowledging fault in one inverter, the two inverters are switched to linked operation.

First, the inverter which is not affected by the fault is also switched off. The DC voltage is checked. When the DC voltages are approximately identical, the tie switch is closed and the inverter which is not affected by the fault is then switched back on. If the DC voltages are still not the same once a certain time has elapsed, the inverter which is not affected by the fault is switched back on. After a delay, a new attempt is made to exit single operation and switch to linked operation in the event of a fault.

4.5.3 Linked Operation in the Event of a Fault

One inverter is switched on and is feeding power into the mains. The other inverter has been shut down due to a fault. The tie switch is closed.

This operating mode is active when one inverter is affected by a fault.

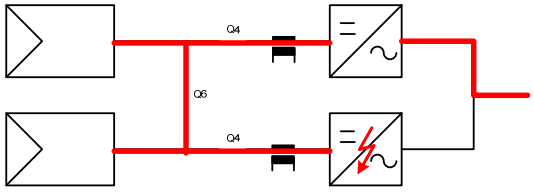

Fig. 10 Linked operation in the event of a fault in partner operating mode

Change of status to linked operation:
The system switches to linked operation when the fault message is acknowledged in the inverter affected by the fault.

The inverter affected by the fault is switched off logically once the fault has been acknowledged.

4.5.4 Partner Operation During the Course of the Day

Early morning:
The tie switch is closed from the previous day. Overnight, a decision has been made as to which inverter will be switched on logically in linked operation on this day and which will be switched off logically. If the sequence control (see Chapter 4.1) of both inverters now switches from the "Night" status to the "Waiting" status, one inverter is switched off logically. The other inverter is switched on logically and feeds power into the mains subject to sufficient levels of insolation.

"Linked operation" is active.

Later that morning:
Insolation increases. As a result, the inverter feeding power into the mains works at increased capacity. If capacity utilisation rises above a certain value, the system switches to single operation. The tie switch opens and the inverter which is switched off logically is switched on.

"Single operation" is active.

Evening:
Levels of insolation fall during the course of the day. The capacity utilisation at which the two inverters are working drops as a result. If the capacity utilisation of the two inverters falls below a certain value, the system switches to linked operation. The tie switch is closed and one inverter is switched off logically.

"Linked operation" is active.

Later in the evening:
Levels of insolation fall further. Capacity utilisation drops as a result. If capacity utilisation falls below a certain value, sequence control on both inverters switches to the "Night" status. Power stops being fed into the mains.

"Linked operation" is active.

Night:
Overnight, a decision is made as to which inverter is to be active in linked operation the next day. So that both inverters work at approximately the same capacity, the inverters are operated alternately.

4.5.5 Partner Operation Parameters

Load threshold for terminating the INV connection:
If capacity utilisation in linked operation rises above the parameter value, the system switches to single operation.

Load threshold for connecting the INV:
If capacity utilisation in single operation falls below the parameter value, the system switches to linked operation.

Maximum DC voltage difference for connecting the INV:

When the system switches from single operation to linked operation, the MPP trackers in both inverters are switched off and an attempt is made to match the DC voltages. The system only switches to linked operation if the difference is less than the parameter value.

5 Monitoring Systems, Messages and Faults

5.1 General

All monitoring systems only generate fault messages when the inverter is switched on; when it is switched off, the inverter is always reported as being free of faults.

A distinction is made between **deactivating**, **self-acknowledging** and **signalling faults**.

Deactivating faults switch the unit off permanently. K7 and Q4 are opened.

The fault can be acknowledged manually or by switching the unit off and on. However, if the cause of the fault is still present following manual acknowledgement, another deactivating fault will be generated.

Self-acknowledging faults switch the unit off. K7 is opened, Q4 remains closed.

The unit starts up again when the cause of the fault is no longer present. The fault can also be acknowledged manually or by switching the unit off and on. However, if the cause of the fault is still present following manual acknowledgement, another self-acknowledging fault will be generated.

Signalling faults do not have any effect on the unit's sequence control. K7 and Q4 remain closed.

A signalling fault acknowledges itself automatically when the cause of the fault is no longer present. The fault can also be acknowledged manually or by switching the unit off and on. However, if the cause of the fault is still present following manual acknowledgement, another signalling fault will be generated.

The following monitoring systems will cause the inverter to switch off, are self-acknowledging or signalling and are shown on the DOU with corresponding plain text:

5.2 Table of Faults

Fault/Message	Deacti-vating	Self-acknowl-edging	Signal-ling	DOU message
Temperature monitoring systems				
IGBT stack temperature warning			X	!Equipment temperature fault!
IGBT stack temperature fault		X		#Equipment temperature fault#
IGBT supply air temp. warning			X	!Ambient temperature fault!
IGBT supply air temperature fault		X		#Ambient temperature fault#
Unit exhaust air temperature warning			X	!Ambient temperature fault!
Unit exhaust air temperature fault		X		#Ambient temperature fault#
Temperature sensor fault, IGBT stack		X		#Temperature sensor fault#
Temperature sensor fault, IGBT supply air temperature		X		#Temperature sensor fault#
Temperature sensor fault, unit exhaust air temperature		X		#Temperature sensor fault#
CAN I/O monitoring systems				
Feedback signal, DC load interrupter switch Q4.1			X	Q4.x: !Switch feedback fault!
Switch position Q4.1			X	Q4.x: Switch open
Feedback signal K21 earthing PV cells			X	K21: !Switch feedback fault!
Monitoring F21 earthing circuit breaker			X	!Miniature circuit breaker tripped!
Monitoring F81 surge voltage arrester DC input			X	!Overvoltage protection tripped!
Monitoring insulation monitor level 1			X	!Insulation monitor warning!
Monitoring insulation monitor level 2			X	!Insulation monitor alarm!
Monitoring mains voltage auxiliary power supply mains 2			X	!Auxiliary power supply - mains failed!
Monitoring F82/F83 surge voltage arrester AC mains 1/2			X	F82/F83: !Overvoltage protection tripped!
Monitoring F60 auxiliary power supply mains 2			X	F60: !Miniature circuit breaker tripped!
Monitoring F61 independent power supply mains 1			X	F61: !Miniature circuit breaker tripped!
Monitoring Q26 AC mains disconnector			X	Q26: Switch open
Monitoring unit cabinet door			X	!Unit cabinet door open!
Monitoring communication CAN I/O AC cabinet			X	!Communication fault with I/O control!
Monitoring communication CAN I/O DC cabinet			X	!Communication fault with I/O control!
Monitoring CAN I/O parameters	X			#I/O parameter error#

Unit monitoring systems				
Monitoring fan fault			X	!Fan failure!
Monitoring K91 feedback signal fan contactor			X	K91: !Switch feedback fault!
Monitoring K7 feedback signal INV output contactor	X			#Fault K7 feedback signal#
Monitoring parameter limits			X	!Parameter limit fault!
Monitoring PCB ID	X			#Self-test fault#
Monitoring EEPROM	X			#EEPROM fault#
Monitoring serial EEPROM			X	!System fault!
Monitoring watchdog	X			#Watchdog#
Monitoring 15 V supply voltage	X			#15 V supply voltage fault#
Monitoring IGBT stack	X			#Stack fault#
Monitoring short circuit/overload	X			#Short circuit#
Monitoring load current transformer	X			#Load current transformer fault#
Monitoring inverter output voltage	X			#AC voltage deviation#
Monitoring stack overcurrent	X			#Stack overcurrent#
Monitoring mains synchronisation		X		#Synchronisation fault#
Monitoring communication parallel CAN			X	!Communication fault parallel CAN!
Monitoring communication remote monitoring			X	!Remote monitoring fault!
DC voltage monitoring systems				
Monitoring DC overvoltage		X		#DC voltage deviation#
Grid monitoring systems				
Monitoring grid overfrequency		X		#Mains frequency deviation#
Monitoring grid underfrequency		X		#Mains frequency deviation#
Monitoring grid overvoltage		X		#Mains voltage deviation#
Monitoring grid undervoltage		X		#Mains voltage deviation#
Monitoring symmetry fault		X		#Mains symmetry fault#

6 Interfaces

PV power stations are usually monitored from a central location. Alongside the PV cells, the inverter is a key component of a power station, which is why several communication interfaces are available as standard.

These include relay contacts and optocouplers, as well as various serial interfaces with protocols for integration into higher-level monitoring systems.

In terms of monitoring PV power stations, AEG also offers corresponding additional components that are adapted for use with inverters and PV generators. This enables the client to monitor an entire PV power station from a central location easily and reliably.

6.1 Communication Interface

The photovoltaic inverter is equipped with a central communication unit, a "MultiCom CCC interface".

As well as performing various other functions, this unit facilitates communication between PV inverters and higher-level monitoring systems.

A special system of central monitoring via the Internet can be realised using AEG monitoring components such as the "PV.LoG". The connection between the inverter and PV-LoG has been optimally adapted for monitoring and management purposes and is established via the Modbus protocol. If you have any further questions, please contact your supplier.

6.1.1 General

Two separate potential-free serial interfaces are provided as standard for the purpose of establishing communication connections. One interface – port X2 – is assigned the AEG-specific protocol CBSER and is used both locally and remotely for corresponding service tools. The other one – port X5 – supports the Modbus protocol and enables the PV inverter to be integrated into higher-level monitoring and control systems with ease. This port can be switched over from RS232 to RS485.

An external CAN bus provides a further connection option, which can be used for monitoring via a remote panel.

The MultiCom CCC interface can be found on the pivot inside the AC cabinet (item A29.1; see the assembly diagram).

6.1.2 Technical Data

MultiCom CCC hardware data (assembly A29.1)

Connector :	**Port 1** RS232 for configuration and COM server connection
	X2: 9-pin D-sub (socket; insulated)
	Port 2 RS232/RS485 for Modbus
	X5: 9-pin D-sub (socket; insulated)
RS485 connection:	Twisted pair with Data+, Data-, shielded, shield attached on one side
Distance:	1200 m max. at 9600 baud
Bus stations:	Max. 32
Data line:	Shielded 1:1 (2 x 0.22; twisted pair), e.g. Lapp "UNITRONIC-BUS LD"
	Port 3 CAN bus for remote panel X4: 3-pin Combicon connector

Communication data port 1 (X2)

Protocol:	CBSER
Transmission rate:	1200 - 57,600 baud (variable)
Transmission parameters:	**9600 baud, 8, E, 1** (**default**)
Configuration mode:	9600 baud, 8, N, 1

Communication data port 2 (X5)

Protocol:	Modbus
Transmission mode:	Half-duplex
Transmission code:	RTU
Transmission rate:	1200 - 57,600 baud (variable)
	19,200 baud (**default**)
Start bits:	**1**
Data bits:	**8**
Parity:	none, **even**, odd (variable)
Stop bits:	2 with no parity, 1 with parity
Function code:	03 (read register) 06 (write register) 16 (write multiple registers)
Min. response time of slave:	0-99 ms variable (**0 ms default**)
Modbus slave address:	01-99 (variable) (**01 default**)

Communication data port 3 (X4)

Protocol:	Proprietary CAN bus
Transmission rate:	50 kbaud

6.1.3 Structure of the MultiCom CCC Interface

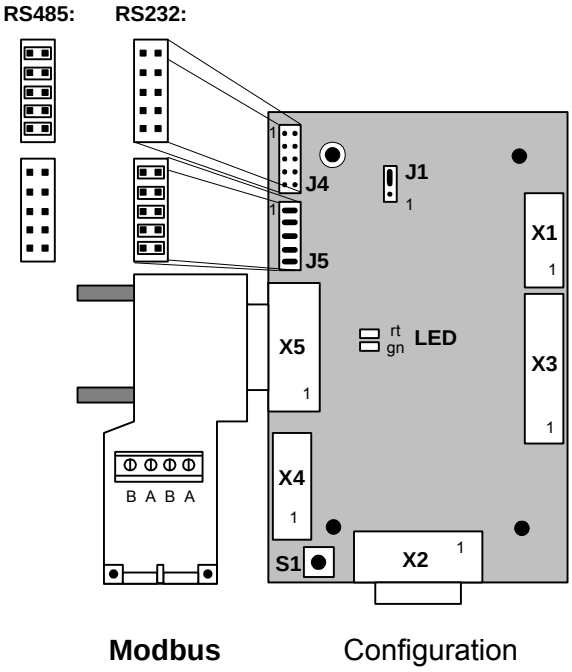

Fig. 11 MultiCom CCC interface as a Modbus interface (top view)

Connections:

X1: Internal inverter bus and power supply

X2: Potential-free RS232 serial interface

X3: Triggering of "remote signalling"

X4: A remote panel can be connected to this potential-free CAN interface.

X5: Potential-free RS485/RS232 serial interface

Configuration jumpers:

J1: 1-2: firmware update; 2-3: (**default**)

J4: All closed: RS485 (**default**)

J5: All closed: RS232

The transmission topology of the Modbus interface (connector X5) is set with the two configuration jumper blocks (J4/J5). The factory setting is RS485.

In order to be able to use the Modbus interface as a point-to-point connection via RS232, you must remove all jumpers from block J4 and plug them in on block J5.

Button:

S1: Button for initiating the configuration via connector X2

LED signals:

Green/red flashes:	Configuration can be selected via the terminal (up to 30 seconds after restarting)
Green on:	Operating status; no external communication via X2 and X5
Green flashes:	Data transmission on the serial interfaces (X2 or X5)
Red on:	Fault

Description of serial interfaces:

Port 1: Serial interface X2

The potential-free RS232 serial interface at connector X2 is equipped with the AEG-specific CBSER protocol for parameter setting and monitoring purposes. Special service tools can be used to monitor and manage the system locally and (with the aid of the COM server) remotely via a network. This is also the port used for configuring the assembly's interfaces.

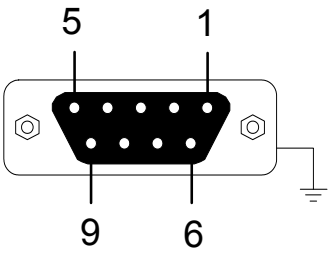

Fig. 12 Serial D-sub connector X2

Port 1 (X2): RS232 pin assignment

Pin number	Signal	Description
2	RxD	PC receiving data from the MCC
3	TxD	PC sending data to the MCC
5	GND	Interface reference potential
Housing		INV housing potential

Please use a 1:1 data cable for configuration purposes.

Port 2: Serial interface X5

The potential-free RS485 interface at connector X5 supports the Modbus protocol for integration into higher-level monitoring systems.

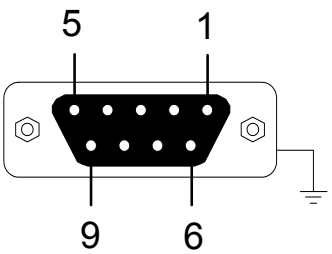

Fig. 13 Serial D-sub connector X5

Port 2 (X5): RS485 pin assignment (default)

Pin number	Signal	Description
3	B	High data
8	A	Low data
Housing		INV housing potential

Please use a shielded fieldbus cable as the line,
e.g. 2 x 0.22 twisted pair Lapp "UNITRONIC-BUS LD".

Please connect the RS485 bus line via the bus interface connector supplied. In an RS485 network, the ends of the bus must always be terminated. If required, insert the 120R resistor supplied between connections A and B.

Shield connection of the RS485 bus line:

Shielding is a means of weakening (attenuating) magnetic, electrical or electromagnetic interference fields.
Interference currents on line shields are dissipated to earth by means of the shield busbar that has a conductive connection to the housing. A low-impedance connection to the PE conductor is especially important to prevent these interference currents from themselves becoming a source of interference.

If possible, only use lines with a braided shield. The shield coverage should be at least 80%. Avoid using lines with a foil shield because tensile and compressive stresses applied when fastening the line can easily damage the foil, resulting in a reduction in the shielding effect.

Please bear the following points in mind when handling the shield:

- Use cable clips or shield terminal blocks made of metal to secure the braided shield. The clips must surround the shield and make good contact with it over a large area.
- Route the shield on a shield busbar directly from where the line enters the cubicle. Route the shield right up to the assembly; however, ensure that it does not make contact there!

When used in PV applications, the shield of the RS485 bus line should only be earthed on one side so that no equalising or interference currents can flow through the shielding. However, if several bus stations are present, you must make sure that the shield is never interrupted.

Please always **attach** the **shield** of the RS485 bus line to earth on the quiescent side, i.e. only **one side** of the shield is attached to **earth on** the **master** or **data logger side**.

In the PV inverter, the shield must not be connected to the housing in any way.

Insert the RS485 **bus cable into** the **unit until** it reaches the **MultiCom interface**, **shorten** it accordingly **and** attach **both wires to** terminals **A** and **B**.

The X5 interface can be switched from RS485 to RS232 with jumpers J4 and J5. The factory setting is RS485, i.e. all jumpers are inserted at J4. You have the option to switch the interface to RS232 by reconnecting all jumpers to J5.

Port 2 (X5): RS232 pin assignment

Pin number	Signal	Description
2	RxD	PC receiving data
3	TxD	PC sending data
5	GND	Interface reference potential
7	RTS	Handshake
8	CTS	Handshake
Housing		INV housing potential

If the RS232 version is used for this port, please use a 1:1 data line.

Controller Area Network (CAN) at X4

Up to four remote panels can also be connected to the potential-free CAN interface for central signalling and display.

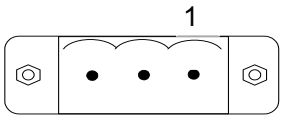

Fig. 14 Connector X4

Port 3 (X4): CAN pin assignment

Pin number	Designation	Cable colour coding
1	GND	White + brown
2	Data_L	Yellow
3	Data_H	Green

Please use a shielded CAN bus cable as the line,
e.g. 2 x 0.22 twisted pair Lapp "UNITRONIC-BUS LD".

Route the CAN bus line from the PV inverter to the remote panel. In a CAN bus network, the ends of the bus must always be terminated. A 120R terminating resistor is pre-installed at connector X4 of the CAN bus connection as standard.

Connect the **line shield to** the **housing potential of the INV unit** via shield terminal blocks. Openings are provided in the plate of the PV inverter for installing the shield in the connection room area. Remove approx. 20 mm of the sheath at this point.

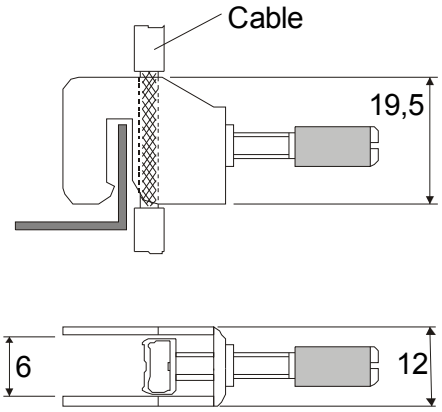

Fig. 15 Shield connection

6.1.4 Configuration

The communication interface does not have to be configured in order to connect the PV inverter to the data logger system of the AEG "PV.LoG". Once the bus cable has been installed and the system has been powered up, the configuration settings are made fully automatically.

If you are using a different/in-house monitoring system, you can adjust the transmission parameters and the slave address of the Modbus interface to suit your requirements via port 1 (X2). We would be happy to provide you with the Modbus unit profile on request.

6.1.4.1 Configuration Preparations

You will need a 1:1 data line and a PC.

To carry out the configuration, you must now **connect** the **PC to** the **MultiCom interface** (X2) with the **data line** and **start** a **terminal program**, such as HyperTerminal, on the PC.

Setting the terminal program:

Data transmission:	COMx, 9600 baud/8 data bits/1 stop bit
	No parity/no protocol
Terminal emulation:	VT100

You can then **start** the **configuration** by **pressing** the **"S1" button** on the MultiCom interface. You must make sure that no communication has taken place via the X2/X5 interfaces for at least the previous 10 seconds.

The start of the configuration is indicated by two **flashing LEDs** on the MultiCom interface and by the following message on the terminal display:

„**PRESS <CR> FOR CONFIGURATION WHILE LED IS FLASHING**"

The **configuration starts**, providing you **press** the **<ENTER> key** (<CR>) **within 30 seconds**. The configuration main menu is opened:

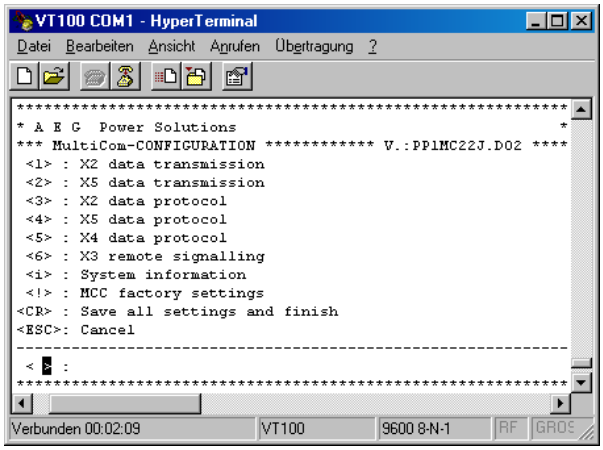

Fig. 16 Main menu

If the configuration does not start, you must wait for 10 seconds and repeat the procedure. Make sure that no data is received via the X2/X5 interfaces during this time.

Press one of the following keys in the **main menu**:

- **<CR>** to **save all settings**, finish the configuration **and activate** the **MultiCom interface**.
- **<ESC>** to **cancel** the configuration.
- **<2>** to access the **X5 data transmission configuration**.
- **<4>** to access the **X5 data protocol configuration**.

The possible keyboard actions are shown in the menu in "< >".

The following **special keys** can be used in all menus:

<**CR**>: **C**arriage **R**eturn (↵) or ENTER key
<**ESC**>: **Esc**ape key
<**TAB**>: **Tab**ulator (→) key
<**BS**>: **B**ack**s**pace (←) or rubout key
< >: Space bar

6.1.4.2 Configuring the Modbus Protocol

To access the **X5 data protocol configuration**, you must press **<4>** in the **main menu**:

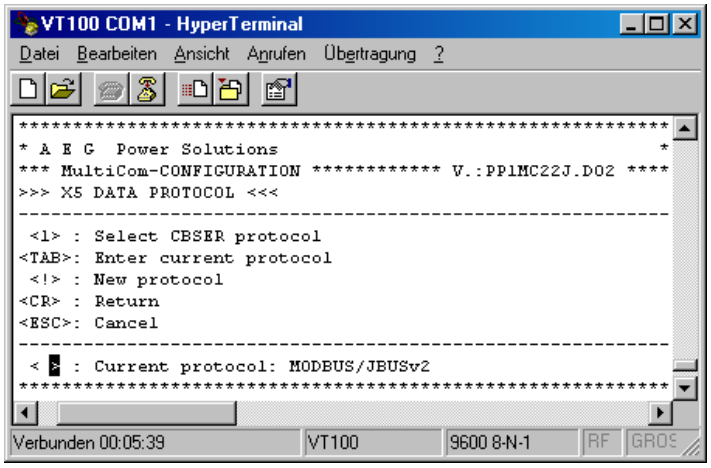

Fig. 17 Data protocol configuration

Press one of the following keys in the "**X5 Data Protocol**" menu:

- **<TAB>** to **configure** the Modbus **protocol**.
- **<CR>** to **save** all **settings**. The configuration is finished and the main menu is opened again.
- **<ESC>** to **cancel** the configuration. This opens the main menu.

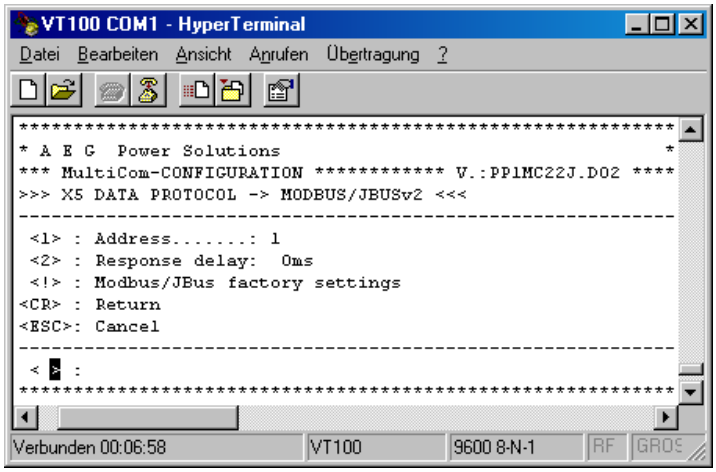

Fig. 18 Modbus protocol configuration

Press one of the following keys in the "**X5 Data Protocol – Modbus/JBusV2**" menu:

- **<!>** to **load** the **factory settings**.
- **<1>** to **configure** the **Modbus slave address**.
- **<2>** to **configure** the **delay time between** a **request** from the master **and** the **response** from the slave.
- **<CR>** to **save the settings**. The configuration is finished and the main menu is opened again.
- **<ESC>** to **cancel** the configuration. This opens the main menu.

6.1.4.3 Configuring Modbus Data Transmission

To access the **X5 data transmission configuration**, you must press **<2>** in the **main menu**:

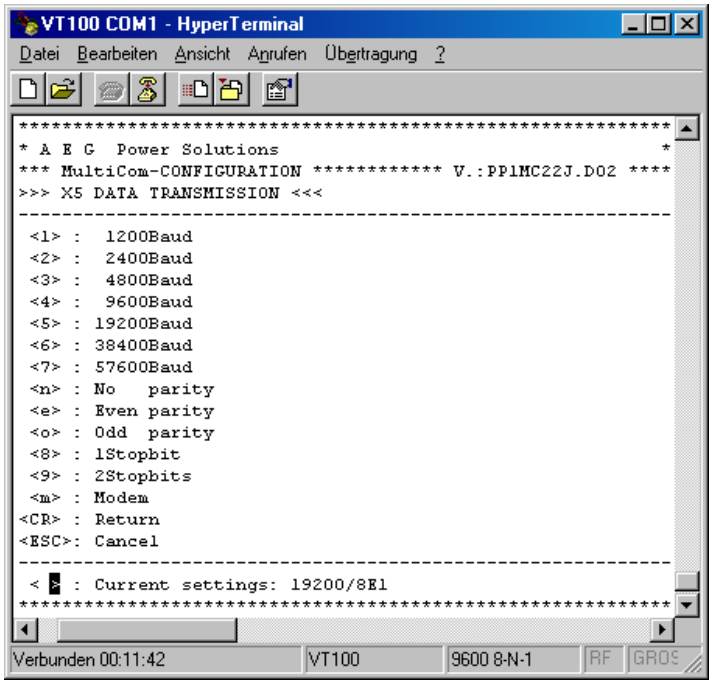

Fig. 19 Modbus/JBus data transmission configuration

Press one of the following keys in the "**X5 Data Transmission**" menu:

- **<1-7>** to set the **baud rate**.
- **<n,e,o>** to set the **parity**.
- **<8,9>** to set the **number of stop bits**.
- **<CR>** to **save the settings**. The configuration is finished and the main menu is opened again.
- **<ESC>** to **cancel** the configuration. This opens the main menu.

The **Modbus factory setting** is: **19200 8 E 1**.

6.2 COM Server

6.2.1 General

The COM server makes the serial port of the PV inverter available via an Ethernet network. A software application can communicate with the PV inverter via the network using a virtual COM port (this needs to be installed on a server or a workstation). The COM server is installed as standard and is used by the AEG service department for remote maintenance purposes. An appropriate Ethernet network with an Internet connection and a fixed IP address assignment is required here.

An assembly made by W&T is used as the COM server. It is an industrial version for 10 Mbit and 100 Mbit Ethernet networks. The COM server is item A27 in the system's AC cabinet; see Figure 4.

6.2.2 Network Connection

This COM server has an IEEE 802.3-compatible network connection on a shielded RJ45 plug connector. Its assignment corresponds to that of an MDI interface, which means the connection to the hub or switch is made using a 1:1 wired patch cable.

Ex-works, the COM server operates in an autonegotiation mode on the network side. This means the data transmission speed and the duplex process are automatically negotiated with the connected switch or hub and are set accordingly.

6.2.3 COM Port

Ex-works, the COM port is set so it can communicate directly with MultiCom interface connector X2 of the PV inverter via RS-232.

6.2.4 Power Supply

The power supply is connected at the screw terminal blocks located on the underside of the housing. A DC voltage of any polarity may be used. The protection against polarity reversal means the following maximum and minimum values apply to the supply voltage:

- 12 VDC (-10%) – 24 VDC (+10%)

A corresponding switch mode power supply in the PV inverter supplies the COM server with power.

6.2.5 LEDs

Power LED

This signals that the supply voltage is connected. If this LED does not light up, please check that the supply voltage is connected correctly.

Status LED

This flickers when there is any network activity on the serial port. Periodic flashing indicates that the port has a valid connection to another network station.

Error LED

This uses different flashing codes to indicate error statuses on the COM server or the serial port.

1 x flashing = Check network connection
The COM server cannot receive a link pulse from a switch or a hub. Please check the cable or the network components.

2 x flashing = Check serial data format
At least one mark with a parity/frame error was received on the serial port. Please check that the set serial parameters and the serial data cable are correct.

All LEDs on = Self-test fault
The self-test performed after each start or reset of the COM server could not be terminated correctly. This fault can occur if you have cancelled an update of the COM server prematurely.

Please refer to the supplied manual on the CD-ROM from W&T for more information about the COM server.

6.2.6 Installation of the Virtual COM Port

In order to communicate via the COM server, it must be integrated into the network and a virtual COM port must be set up on a computer.

6.2.7 Network Integration Configuration

For network integration you will need a **free IP address** for the **COM server**, the **subnet mask** and the **IP address** for the **gateway**. This information can be obtained from your administrator if necessary.

- Now please remove the product CD from the W&T quick-start instructions supplied and start this CD-ROM on a computer in the same subnet as the COM server, then please install the "WuTility" tool.
- Use the "Scan" button to search the local network for W&T devices. If several devices are found, please select the device to be configured on the basis of its Ethernet address. This can be found on the sticker on the COM server, and starts with EN=00c03dxxxxxxxxx.
- Select the required device and press the "Assign IP address" button. Please enter the necessary parameters here.
- Save and exit; the COM server is now installed in the network.

- Please use the "ping" command to test that the COM server can be reached in the network.

For additional detailed information, please refer to the quick-start instructions as well as the manual on the CD-ROM.

6.2.8 Configuration of the Virtual COM Port

To install the virtual COM port on your operating system, you have to start the CD-ROM in the computer in question.

- Please select the "Com Server" button in the top line of the main window of the product CD. The reference to the COM redirection appears, amongst other items.
- Please click the corresponding "Browse" button. A new dialog box appears with the prompt to select the operating system.
- Click the plus sign on the left of the window in order to be able to run this operation.
- Now select your operating system and perform the installation using the "Install" button.

Following installation, the dialog box for the virtual COM port appears with the IP address of the COM server. Here, you can change or adapt the name of the COM port using the "Numbering" button. Once you click "OK", the virtual COM port is installed.

For additional detailed information, please refer to the manual on the CD-ROM.

6.3 Remote Signalling

The remote signalling board is a contact interface for signalling PV messages and controlling PV units. It is supplied as an option for the AEG PV system and is intended for installation in the PV unit. The remote signalling master board consists of 5 potential-free signalling contacts and one control input.

There is an independent 24 VDC power supply for the control input. The control signal is activated by bridging the relevant input. There is no need for an additional auxiliary power supply.

The signals are assigned as standard or can be configured on a customer-specific basis. An integrated service switch enables maintenance work on the unit to be signalled.

Technical data:

The maximum load of the **signalling contacts (X3/X4)** is **250 V/8 A AC or 50 V/2 A DC**.

NOTE:
If the specified power has been applied to the relay contacts once, those contacts can no longer reliably switch an extra-low voltage (evaporation of the gold alloy)!

The **control input (X5)** has an **independent** 24 VDC **power supply**. The input is activated via a bridge.

Structure:

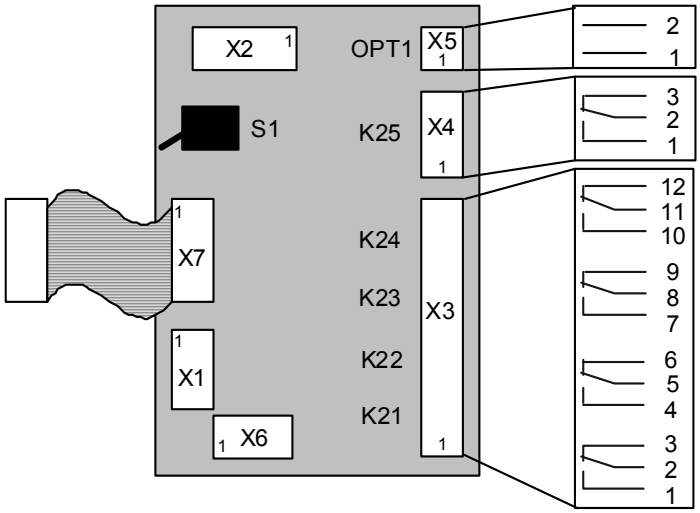

Fig. 20 Remote signalling master module A12 (top view)

X1:	Power supply connection
X2:	Connection for remote signalling expansion board
X3/X4:	Remote signalling outputs with relay changeover switches
X5:	Remote signalling input via optocoupler with independent power supply
X6:	Service plug
X7:	Connection to a MultiCom interface
S1:	Service switch

X3: When a signal is received, the **contact** between the two contact points with the lower numbers **is closed** (**normally open or "NO"**).

X4: When a signal is received, the **contact** between the two contact points with the lower numbers **is opened** (**normally closed or "NC"**).

X5: The **control signal is active** when the **input is bridged (normally open)**. The inverter is switched off.

The following **default signals** are used for remote signalling:

X3.1-2 3	**Inverter feed operation**	**(NO)**
X3.4-5 6	**DC distribution message***	**(NO)**
X3.7-8 9	**AC distribution message***	**(NO)**
X3.10-11 12	**Incoming mains fault**	**(NO)**
X4.1 2-3	**Inverter fault***	**(NC)**
X5.1-2	**Inverter remote switch-off**	**(NO)**

*): Collective signals that contain all messages and faults

Fig. 20 shows the normally closed contact in the state that applies when the signal is not active (normally open) or the voltage is zero.

The **service switch** enables maintenance work on the unit to be signalled to the MultiCom interface using various protocols.

7 Graphical Display and Operation Unit

7.1 General

The graphical **d**isplay and **o**peration **u**nit (DOU) is integrated into the front of the solar inverter. It serves to signal and visualise unit data and to control the inverter system. The DOU consists of a display unit with 3 LEDs, a graphical LCD and an operating panel with 5 keys.

The global unit status can be read from the 3 LEDs. An acoustic signal generator stresses the urgency of critical system statuses.

The graphical LCD shows system statuses and measured values using symbols and plain text. You can control and parameterise the unit using menus which are protected by a password.

The DOU is operated using 4 display keys, to which alternating functions are assigned, and one ENTER key. The key functions that are currently active are shown on the LCD in the form of symbols.

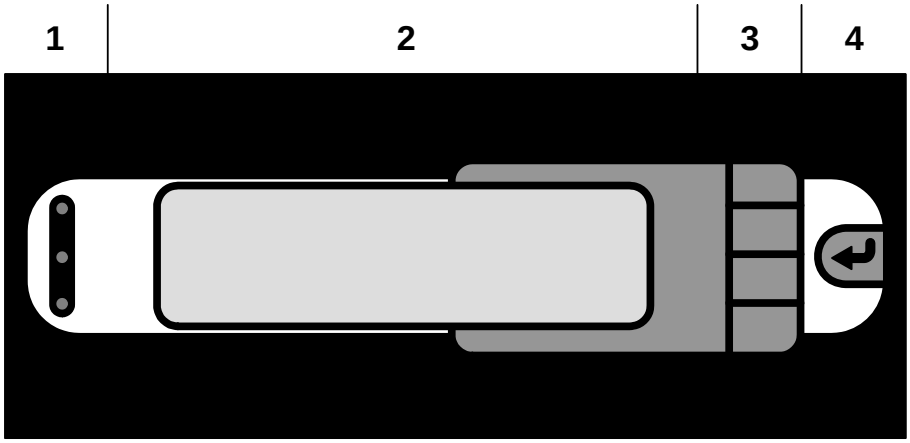

Fig. 21 DOU

1 LEDs: Red, yellow, green (from top to bottom)
2 Graphical display (LCD)
3 4 general function keys
4 ENTER key

7.1.1 Signalling

LEDs:

Red, permanently ON:	Deactivating fault (must be acknowledged via the menu)
Red, flashing:	Self-acknowledging deactivating fault
Yellow, flashing:	Self-acknowledging messages
Green OFF:	INV in sleep mode
Green, flashing (1 Hz):	INV waiting for feed conditions
Green, flashing (0.5 Hz):	INV feeding into mains with derating
Green, permanently ON:	INV feeding into mains

Acoustic signal generator:

Signal generator ON: Urgent messages and system fault

7.1.2 Keyboard Operation

You can use the **ENTER key** to **open and close submenus** and to **acknowledge control functions and parameters**.

The **4 display keys** are assigned to **different functions**. The key functions that are currently active are represented as symbols which can be found in a small framed area on the right-hand side of the LCD.

In the "**Operating display**" and "**Inverter**" menus, you can **switch** the **inverter on and off** using the general keys. The keyboard symbols in the menu indicate the control function which is currently available. If a switch-off procedure has been initiated, you must confirm it by means of a security prompt in order to avoid inadvertent switching off. The general control system of the inverter can be blocked and protected with a password.

If a **unit fault** occurs, refer to the "**Inverter**" menu, where the cause is specified. After eliminating the cause, **acknowledge** the fault in the menu. You can then switch the individual converters back on again.

You can **acknowledge** the **acoustic signal generator** using the **keyboard**. On the LCD operating display you will find a special acknowledgement key represented by a loudspeaker symbol. In all other menus, you can press any key (even a key to which no functions have been assigned) to acknowledge the generator. If the number of messages or faults increases, the acknowledgement is cancelled. You can impose a general block both on the acoustic signal generator from notifying you of faults and on the clicking sound when you press a key.

Possible keyboard symbols and their function:

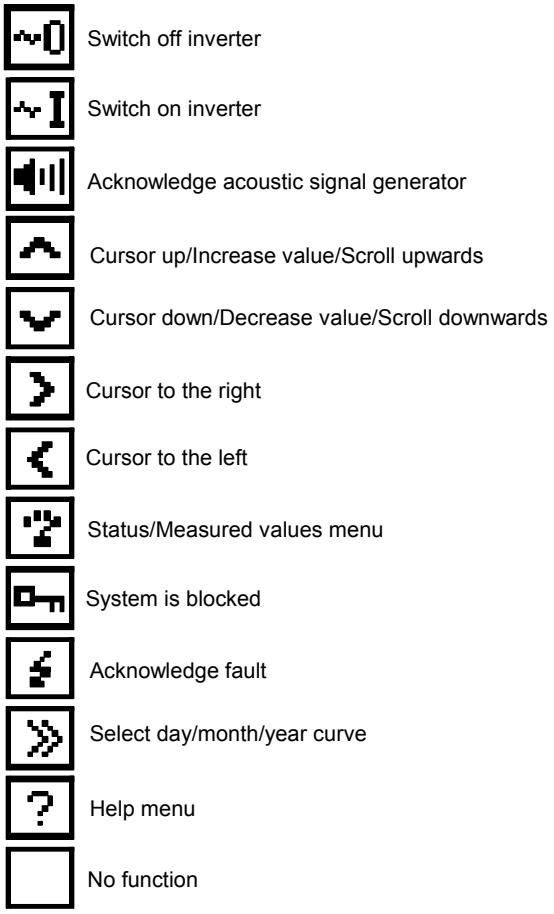

Fig. 22 Keyboard symbols

7.2 Start-Up

Following the **power-up reset**, the DOU performs a self-test. Data is read from the inverter once the test has been completed successfully. The LEDs light up in sequence during this phase. A start screen appears on the LCD and a status bar indicates the duration of the start-up process.

When you **start up the DOU for the first time**, select the menu language using the general keys "<" and ">". The languages that are available are indicated using their respective country-specific abbreviations (the same as those found on car number plates). The language that is currently selected is displayed on a black background. Once you have confirmed the selected language by pressing the ENTER key, the next menu opens. In order to comply with international requirements, all of the displays up to the one for language selection are displayed in English.

7.3 Menu Structure

7.3.1 Menu Tree

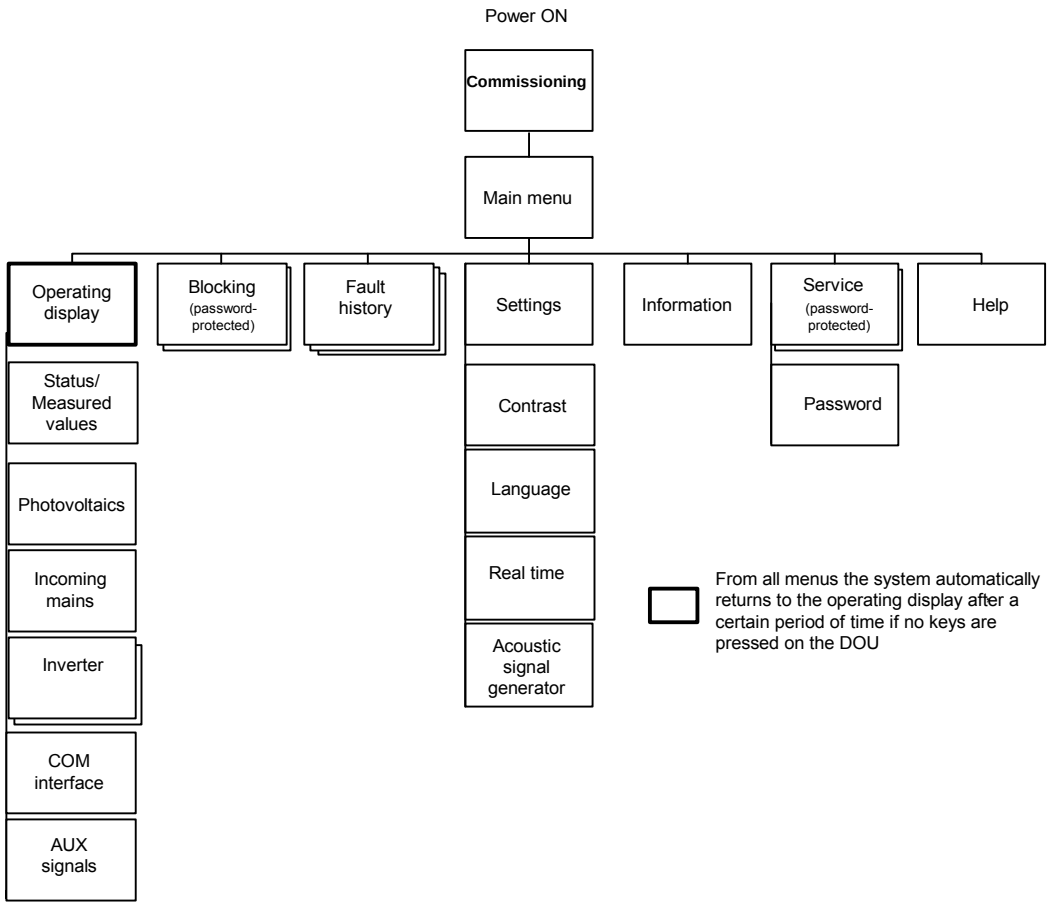

Fig. 23 Menu tree

7.3.2 Main Menu

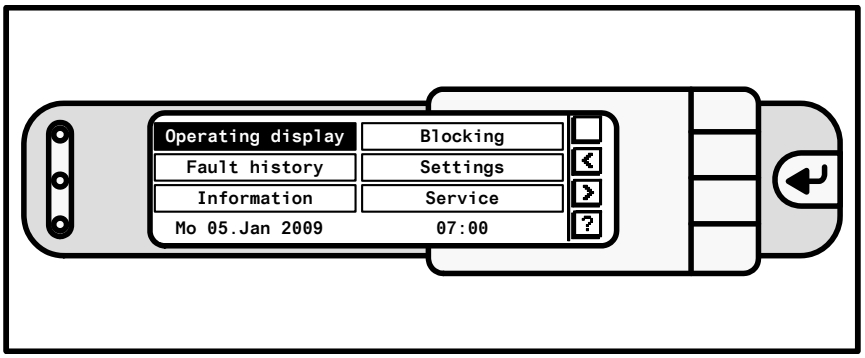

Fig. 24 Main menu

Following start-up, the "**main menu**" is the **highest menu level**, which means that you can open further submenus from here and you can always return to this level.

The **"main menu"** has a typical menu structure.
Additional submenus are displayed on the left-hand side. All selectable submenus are displayed in a frame. A **black background** indicates the **current cursor position**. The bottom line displays the current real time, which can be adjusted using the "Settings" menu.
On the right-hand side, the current key function is represented as a symbol which is displayed in a small framed area. You can **navigate using the "<" and ">"** keys to select the required submenu. Use the **ENTER key** to **open the submenu**. You can use the **"?" key** to call up the "**Help**" menu, which provides descriptions for all the keyboard symbols that are available.

7.3.3 Operating Display

You can call up the "**Operating display**" **from the main menu**.
If the DOU has **not been used for some time**, the system **automatically switches back** to the operating display, no matter which menu it is in.
The LCD background illumination is switched off if no further operations are carried out and the system is not in an abnormal status. In the event of a unit fault, the background illumination remains switched on until the fault is acknowledged. If the **inverter is in night mode**, the content of the **LCD** is cleared and "**Sleep mode**" is displayed instead. The background illumination is also switched off.
You can **reactivate** the **DOU** by **pressing any key**.

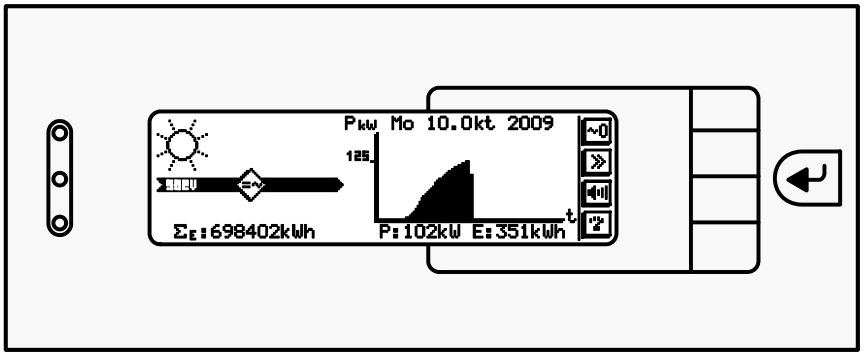

Fig. 25 Operating display – Normal operation

The "**Operating display**" consists of 3 parts:

The left-hand side shows the current global **unit status**:

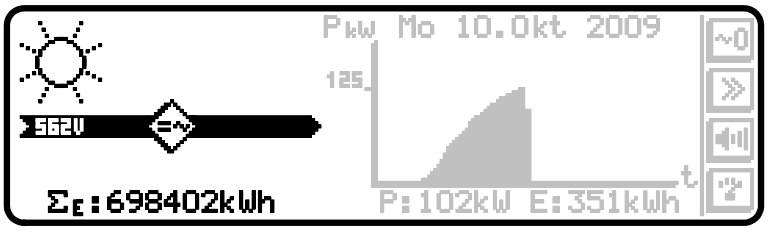

Fig. 26 Operating display – Left-hand side

At the top, a **sun symbol** indicates the **current solar radiation** trend. If the sun is black or a moon symbol is displayed, the PV voltage is so low that the inverter is in its idle state. An empty sun with no rays also indicates that the PV voltage is still too low, with the inverter in standby mode.

The **inverter** is represented in the middle of the left-hand section. If a fault occurs or a message is present, the corresponding symbols flash on the inverter. The bar on the left shows the PV voltage as a symbol and a digital value. If the bar is completely filled in, this indicates that sufficient PV voltage is present. The bar on the right shows the inverter status. If the inverter is feeding power into the mains, the bar is filled in.

The **total energy** fed in is shown at the bottom of the display.

Examples of possible displays:

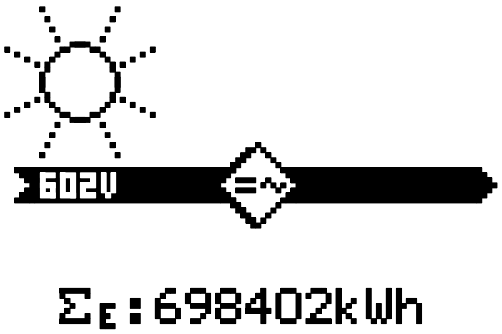

Fig. 27

The system is in its normal state, the inverter is feeding power into the mains.

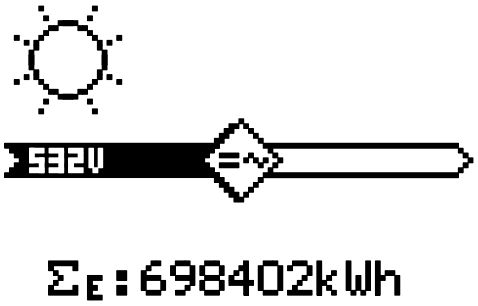

Fig. 28

Solar radiation is sufficient, the inverter is switched off. If the sine symbol on the inverter is flashing, the inverter has been switched off due to a fault or it is currently in the synchronisation phase.

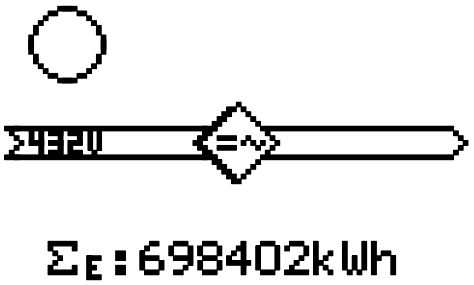

Fig. 29

Solar radiation is too low, the inverter is in standby mode.

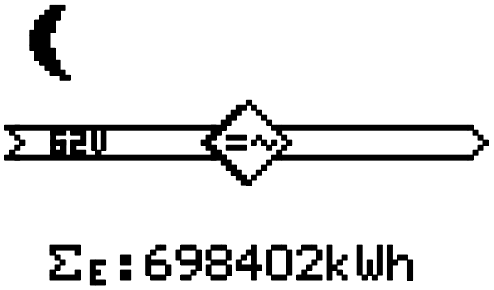

Fig. 30

Solar radiation is too low, the inverter is in its idle state.

The middle section displays the unit's **most important infeed values** in the form of digital values and a graph covering a certain period of time. The **current daily data** is shown **as standard**. This display appears automatically if no keys have been pressed for 1 minute.

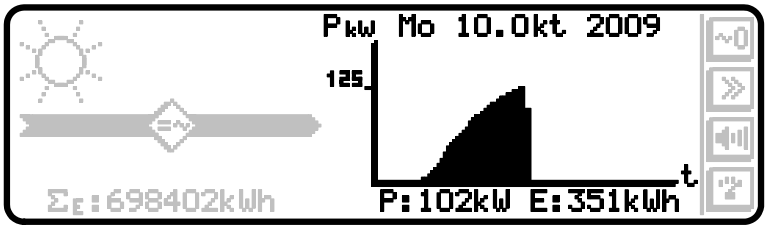

Fig. 31 Operating display – Central section

You can **use** the **double arrow key** to **select the following infeed periods.**

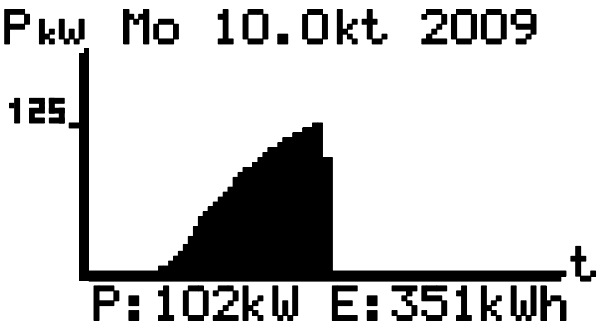

Fig. 32

Daily data for the current day, previous day
(t = 00:00 – 04:00, 15 minute intervals)

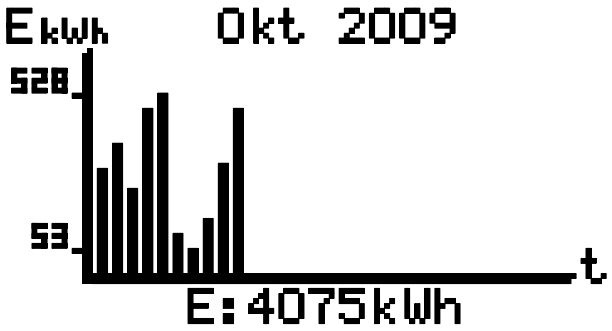

Fig. 33

Monthly data (t = day 1 – 31) for the last 12 months

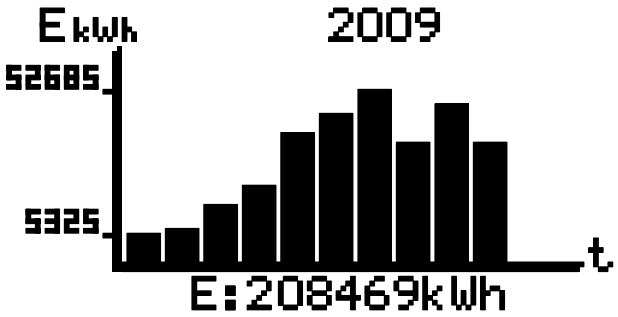

Fig. 34

Current yearly data (t = month 1 – 12)

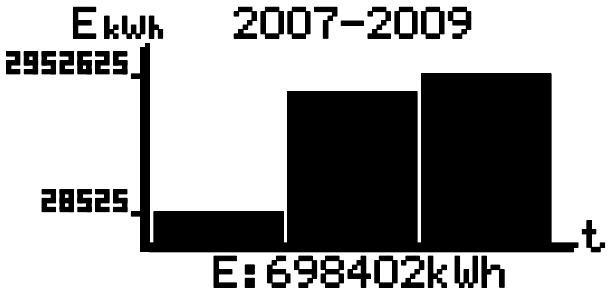

Fig. 35

Yearly overview
(t = year of start-up to current year)

The **current display key assignment** is shown **on the right-hand side**.

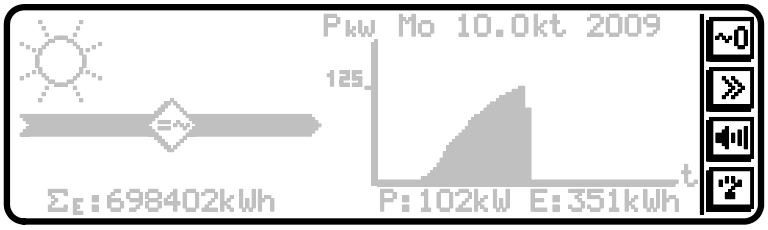

Fig. 36 Operating display – Right-hand side

Here you can **switch** the **inverter on or off**, depending on the unit status. If the **operation has been blocked**, this is indicated here via a key symbol. If a **blank button** is shown here, a **fault** is present. The flashing measured values menu then takes you to the inverter menu, where detailed information can be found on the fault and where you have to acknowledge it.

You can use the double arrow key to select the different **display types for the energy data logger**.
Current day (default) -> Previous day -> Monthly overview -> Current yearly overview -> Yearly overview

If messages have been output or faults have occurred, you can **acknowledge the acoustic signal generator** here; otherwise this key is not assigned.

Use the bottom key with the measuring instrument symbol to call up **menus with detailed information on the status and measured values**. This key flashes in the event of a fault in the unit, enabling you to access menus containing additional fault information directly.

7.3.4 Status/Measured Values

You can call up the **"Status/Measured values" menu** from the operating display using the bottom key with the measuring instrument symbol.
Here you can use the "<", ">", "^" and ENTER keys to open the submenus containing the statuses and measured values for the individual unit components.
Press the ENTER key to return to the Status/Measured values menu.

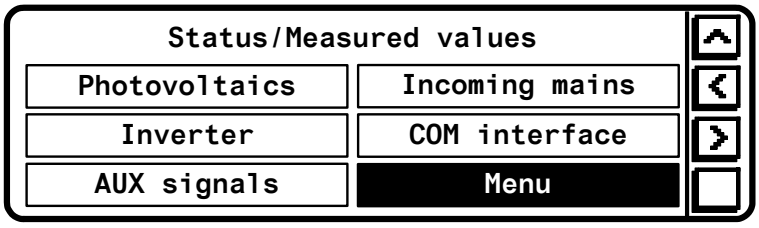

Fig. 37 Menu: Status/Measured values

You can use the "**Photovoltaics**" menu item to display the measured values for the panels. Any faults in the DC distribution are shown here too.

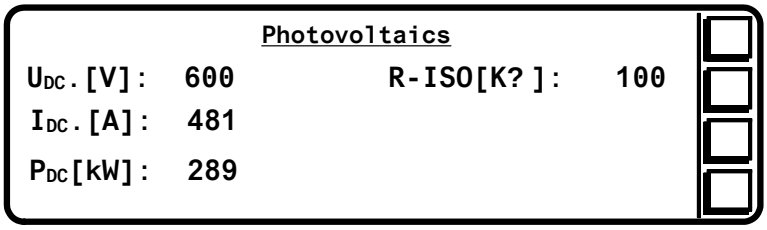

Fig. 38 Photovoltaics menu

You can use the "**Incoming mains**" menu item to display the measured values for the incoming mains. Any mains faults or faults in the AC distribution are shown here too.

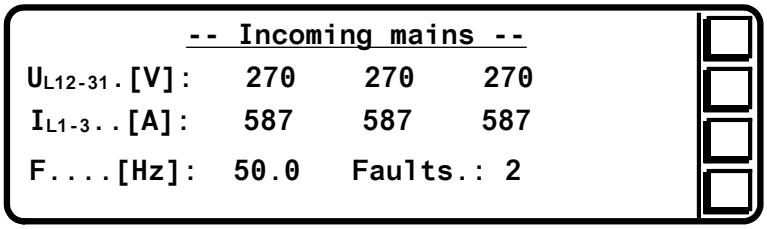

Fig. 39 Incoming mains menu

You can use the "**Inverter**" menu item to display the statuses and measured values for the inverter. You can toggle between the two menus using the ">" and "<" keys.
In normal operation, the inverter can be switched on and off using the top key here. In the event of a **deactivating fault** you can **call up** a **detailed description of the fault** here. **Once the fault has been rectified**, you will need to **acknowledge** it using the top key. A high-voltage symbol "⚡" will then appear on the top key.

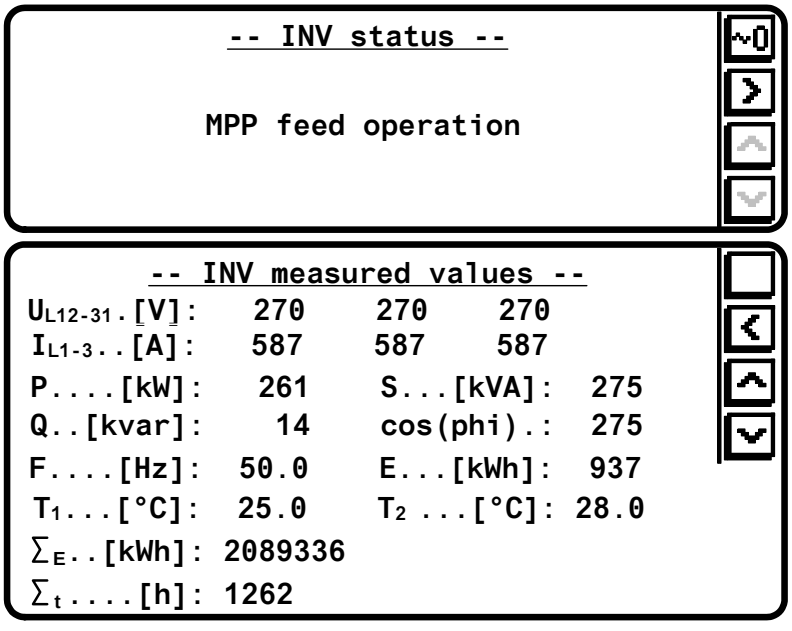

Fig. 40 Inverter menu

The voltage and current of the three phases are displayed as measured values. The power values P, S, Q and cos-phi appear underneath these voltages and currents.
These are then followed by the frequency F and the daily energy E. The ambient temperature of the cabinet T_1 and the supply air temperature of the inverter stack T_2 are shown as the temperatures.

There then follows the total energy counter $\sum_E$ and the inverter operating hours counter $\sum_t$.

You can scroll through the measured values using the "v" and "^" keys.

You can use the "**COM interface**" menu item to look up the statuses of the communication PCBs.

You can use the "**AUX signals**" menu item to look up the status of optional general signals on the remote signalling board.

7.3.5 Blocking

You can call up the "**Blocking**" menu **from** the "**main menu**". After you have entered the current password, you can **block operation** of the inverter (**switching on/off** and **fault acknowledgement**). The password must be entered digit by digit and then confirmed by pressing the ENTER key.

The default **password** is: **1201**.

In menus where switching operations are normally possible, blocking is indicated by a key.

7.3.6 Fault History

You can call up the "**Fault history**" menu **from** the "**main menu**". A **data logger** that records **the inverter's** fault history is integrated in the inverter unit. You can **display** the 20 most recent faults as of the current date or as of another specific date.

7.3.7 Settings

You can call up the "**Settings**" menu **from** the "**main menu**". Here you can set the following parameters in the submenus:

- **LCD contrast**
- **Language**
- **Real time**
- **Acoustic signal generator** for indicating faults and for keyboard operations

7.3.8 Information

You can call up the "**Information**" menu **from** the "**main menu**". Using this menu, you can **look up information** about the unit type, the firmware versions and the available communication options.

7.3.9 Service

You can call up the password-protected "**Service**" menu **from** the "**main menu**". The **password** must be **entered digit by digit and** then **confirmed** by pressing the ENTER key.

The default **password** is: **1201**.

Once the current password has been entered, you can select a submenu where you can change the DOU password.

- In the "**Password**" menu, you can set the password for blocking operation and for setting parameters. A range of 0000 to 9999 is possible.

ATTENTION:
Keep the password secure!

If you have forgotten the password, the DOU will need to be reset at the customer's expense!

7.3.10 Help

You can call up the "**Help**" menu from the "**main menu**" using the "**?**" key. This enables you to look up the **meaning of the keyboard symbols**.